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ABSTRACT

A study was conducted on the enrollments of students (N=13,856) in first and second year science courses at Pima Community College, Arizona, over a 5-year preiod. Of those students who passed these courses with a C grade or better (N=5,974), frequency distributions by sex were made. It was found that the distribution of male/female registered as well as male/female passed was approximately 50 percent. Also, females seemed to do better than males in the upper level science courses. An unusually high dropout rate of students who registered for these courses was uncovered, indicating a possible problem with students selecting science courses without adequate preparation. This drop out rate did not affect the male/female ratio regarding passing the course with a C grade or better. Several recommendations are made: (1) that the college maintain programs to keep the enrollments of female science students at current levels; (2) that some form of program be established to allow female science students to interact with female scientists; and (3) that the college study the reason for the high dropout rate of students in the sciences. Six tables and a 12-item bibliography are included. (Author/JB)

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A STUDY OF THE RELATIONSHIP BETWEEN STUDENT ENROLLMENT IN FIRST YEAR / SECOND YEAR SCIENCE COURSES AND GENDER AT PIMA COLLEGE

Societal Factors Affecting Education

by

David G. Iadevaia, M.A.T.

Pima Community College

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A Practicum presented to Nova University in partial fulfillment of the requirements for the degree of Doctor of Education

Nova University

May, 1989

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ABSTRACT

A study was conducted on the enrollments of students, by sex, in the first and second year science courses at Pima College. Frequency distributions were generated for those students who registered in the past five years and who passed the courses with a C grade or better. Of those students who passed the first and second year science courses, frequency distributions, by sex, were made. It was found that the distribution of male/female registered as well as male/female passed was approximately 50 percent. It was also found that females seemed to do better in the upper level science courses than did males. The study uncovered an unusually high drop out rate of students who did register for these courses indicating a possible problem with students selecting science courses without adequate preparation. However, it was found that this drop out rate did not seem to affect the male/female ratio regarding passing the course with a C grade or better. The fifty percent ratio was maintained.

It was recommended that the college maintain its programs to keep the enrollments of female science students at the current levels. It was also recommended that some form of program be established to allow female science students to interact with female scientists. It was also recommended that the college study the reason for such a high drop out rate of students in the sciences.

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INTRODUCTION

Pima Community College (Pima College) offers the first two years of science education for many students entering higher education in Tucson. A need existed, based on a memo from the Dean of The Science Division, to study how Pima College science enrollments are doing with regards to female students. "This memo serves to confirm our earlier conversation and supports your research efforts in the area of women in physical science", (McCollester: 1989). The Math and Science Counselor also indicated an interest in this study. According to her comments (Arem, 1989),

> I think it will be of enormous value to the Pima College Math and Sciences Division at the West Campus and particularly to our Math and Sciences Advising and Counseling Center.

The study was needed to address the question regarding women in science at Pima College.

Based strictly on biological considerations of male to female distribution in the human population, at least fifty percent of all those involved in the physical sciences should be women. This is not the case. According to Lane (1988:751), "women constitute only about 15 percent of the total engineering/science work force ." Furthermore, out of that fifteen percent less than 13 percent are in the physical sciences (Lane 1988:751). This indicates an under-representation of females in the

physical sciences. Since the physical sciences are prerequisite to engineering programs of study to increase the participation of women in physical science courses might increase women participation in engineering sciences.

There may exist factors unique to gender that could account for this discrepancy. It seems reasonable to assume that before a female is to practice any of the physical sciences, she must first be enrolled in physical science courses. The attrition of females in physical science courses may be time dependant, as indicated by Baker (1983:102), who states that, "approximately half of all undergraduate majors in science are female," he continues, "yet only 10.6 percent of the doctoral degrees in the physical science and 23.4 percent . . . in the biological science are awarded to women." There seems to be some external factors occurring during the baccalaureate program that causes women not to pursue their obvious interest in science.

A "snap-shot" of the first two years of higher education, specifically at Pima College, may reveal interesting trends of female enrollment in the physical sciences as compared to the biological sciences. Therefore, for the purpose of this practicum, the question to be examined will be: Of all students enrolled at Pima College for the last five years, in the sciences, what

percentage of the total were women in the introductory (first year) courses and in the second year courses?

The purpose of this practicum was to compare the gender of those enrolled in the first year science courses to the second year science courses offered at Pima College. A series of frequency distributions were used to bring clarity to the data revealing any trends between gender and course selection.

The literature indicated that various factors account for females not preferring physical science. Attitude seems to be an important factor as Kahle (1988:382) states, "women science majors expressed more positive attitudes toward mathematics . . . than did woman non-science majors." Jones and Wheatly (1988:128) feel that "the masculine/feminine attitudes," based on societal factors regarding gender, is an important consideration. According to Baker (1983:102), "spatial ability is another area in which most researchers report male/female differences."

BACKGROUND AND SIGNIFICANCE

The importance of scientists and engineers in our society can not be over emphasized. As stated by Melissa J. Lane, of the National Science Foundation (1988:750),

> Although engineers and scientists constitute only about 4 percent of the U.S. work force, they are critical in expanding the frontiers of knowledge, developing new technologies, and training future generations.

If it is important to have represented in this group of four percent, an equal number of females, one will find a discrepancy. According to Lane (1988:751), "women constitute only about 15 percent of the total engineering/science work force." As of January 1987, "women accounted for . . . 49 percent of employment in professional and related occupations" (Lane, 1988:751). Since females are approximately 51 percent of the human population it would be expected to find upwards of this number in the work-force. Indeed, women comprise "44 percent of the total employment" (Lane, 1988:751) in the U.S. However, when applied to engineers and scientists as a work-force, women represent 15 percent of that population. This would indicate that woman, on average, are not suited for careers as engineers or scientists. Could this imply that these fields are somehow detrimental to woman? Are women not capable of the rigor required to succeed in these areas? Is there indeed a gender related cause that precludes women from these fields?

How does one decide on the factors which cause women to avoid science and engineering careers?

A logical place to start would be at the biological level. In the 19th century "Paul Broca and his proposal that the smaller brain size of women indicated a measurable reduction in intelligence" (Etheridge, 1982:4) while causing much debate, seems to be a good place to begin. If there is evidence that brain size is an indication of intelligence, then the answer is arrived at and the questioning is completed. However, the question might be raised as to whether brain size indicates intelligence or a function of brain activity which may indeed be different in males and females. For example, according to Baker (1983:102), "spatial ability is another area in which most researchers report male/female differences . . . " If spatial ability is the major difference between males and females and if this ability is required to be a scientist or an engineer, then women may never be equally represented. Is there evidence that women are biologically predetermined not to excel in the sciences or engineering?

A careful examination of the data reveals that "approximately half of all undergraduate majors in science are female" (Baker, 1983:102). It would seem that through the baccalaureate program women are represented in science classes at a biologically consistent level of

approximately 50 percent. This finding would necessarily negate the spatial argument. Although, Baker (1982:102), goes on to state, "yet only 10.6 percent of the doctoral degrees in the physical sciences and 23.4 percent . . . in the biological sciences are awarded to woman." Possibly it is not prudent to totally disregard spatial ability just yet.

The physiological effects would seem to be the next logical place to look for differences. In this category attitudes about science may have a bearing on the numbers of females in the sciences. Kahle (1988:382), states that "woman science majors expressed more positive attitudes toward mathematics . . . than did women non-science majors". This is consistent with Dale Baker's findings that "differences in attitudes . . . reflect major (course of study) rather than (did) sex" (1981:6). The idea of attitude seems to be a recurrent theme in the literature, regarding choice of male or female in selecting science/engineering as a career choice. Baker further states (1981:6),

> It appears that factors influencing a choice of a career in science are spatial ability and attitude toward science for both males and females. For women, the attitudinal factor is more important than the cognitive factor, although how these two may be related is unclear. Nevertheless, once women are in science it is not possible to distinguish them from men on the basis of attitude or spatial ability.

Can this attitude be conceived in male/female terms? So it would seem. After applying the Personal Attributes

Questionnaire and the Myers-Briggs Type Indicators, Baker concluded that there are certain individuals, based on their personalities, who seem to choose science as a career choice. Baker (1983:102) found that "they are likely to be intuitive and introverted, preferring to base decisions on logical analysis". Baker also found that most people in science seem to be "masculine" in outlook. This essentially means that these people exhibit "dominance, aloofness, detachment" (Baker, 1983:102). According to Baker, Spence and Helmreich found that female scientists were more "androgynous" . . . and were more "masculine" than college woman in general" (1983:102). Interestingly more women select biology than the physical sciences which seems to be stereotypically more "feminine". Could there be a third area to examine? Are there social actions which predetermine women from not selecting science?

From the social perspective "there may or may not be biological explanations for sex differences in science achievement, but it is obvious that sociological factors play an important role" according to Jones and Wheatly (1988:128). Jones and Wheatly confirm Baker's assumption regarding the masculine/feminine attitudes and conclude that ". . . traits of scientists are more often associated with masculinity" (1988:129). The lack of role models, which send a subliminal message to females that science is indeed male dominated, could be an area in which to take

corrective action. However, without adequate numbers of females in science, this seems impossible to correct. Sex bias, on the part of the professor, either knowingly or not seems to send the wrong message to females in science classes. How the professor interacts with males and females seems to indicate attitudes the professor has toward one sex regarding expected achievement. The introduction of sex bias begins practically at birth. The toys children play with seem to enhance socially accepted patterns of response. However, if all of these social sex biases are present how is it that half of the population of science majors, at the baccalaureate level, are women?

A question to ask at this time is whether the social sex biases are caused by certain cultural attitudes or are the social sex biases a result of biological evolution? If these biases are cultural we can change them. If these biases are rooted in our biology we must accept them. It seems that women make a life choice as they age regarding such things as raising a family. This activity could be perceived by women as inconsistent with a scientific career. Are there biological demands on most women which men never really consider? It may be possible to cause women to rethink a career in science as precluding marriage and family. If anything, such a career would allow a woman more flexibility. The business of science and engineering could be well suited in a home centered

situation, provided the person entering the field carefully selects an area of science which is flexible. One would think that as the educational level of an individual increases, the ability for finding options also increases. Once a woman is in the undergraduate science curriculum it would make sense to expose her to the various options. This is the critical time for decision making. While the average age of students increases, unfortunately, the options in the sciences decrease, for a time. The demands of a family will not usually allow the needed time to complete a course of study in the sciences. However, the choice should be made early on, during high school or after the family is completed, for best results. Obviously, societal attitudes must change for this to be successful. What is needed is an attitude that does not diminish a woman's reproductive powers but accommodates them. One of the primary functions of any species is to continue itself. In an informal verbal survey, of several female physics students, it was discovered that the primary concern which would limit these students' career choice in science or engineering was the "limitations imposed by such a choice on raising a family", (Iadevaia, 1989).

This finding seems to be consistent with Baker's observation that (1983:107),

> Even some women at the most prestigious schools in the nation see careers as something to do before children are born or after they are grown . . . many feel uncertain that the roles of wife and mother are compatible with a career as demanding in terms of time and effort as science.

This is not to imply that Pima College is a prestigious school, but that women do share common ideas and concerns regardless of their educational institutional affiliation. Etheridge concurs (1982:7),

> Vetter perceives conflicts between family and career commitments as a significantly limiting factor . . . (according to Hornig) the only thing wrong with woman in science is that they don't have equal access to good jobs.

In summary, in order to increase participation of women in the sciences an attitude adjustment must be made, not regarding the academic role but the societal role of women. The needs of those women who choose family and a career in science and how best to accommodate these needs must be met if women are going to participate in science to a greater degree.

PROCEDURES

Definition of the Population

The population of students who had registered for the first year and second year science courses consisted of 13856 students. Of that total population 5974 passed the first year and second year science courses with a C grade or above. The population used for this study contained only those students who passed the first and second year science courses, with a C grade or above, at Pima Community College during a five year period beginning with the Fall 1983 semester and ending with the Spring 1988 semester. A breakdown of this population, by sex, is presented in Table 1.

Table 1

Population by Sex

Sex	Absolute Freq.	Adjusted Freq. (%)
Male	3132	52.4
Female	2842	47.6
Total	5974	100.0

The ethic and racial make-up of the population is presented in Table 2.

Table 2

Ethnic and Racial Composition of the Population

Group	Absolute Freq.	Adjusted Freq. (%)
Indian	96	1.6
Black	195	3.3
Oriental	237	4.0
Spanish	1032	17.3
Other	4405	73.7
None	9	.2
Total	5974	100.0

Collection of Data

A programmer, from the Pima College computer department, was assigned to collect the data for this study. The records of all those students who have completed the first and second year science courses at Pima College, with a C grade or better, were examined. A file of those students was built. This file contained the information regarding sex, ethnicity, race and grade for each student in the group studied. The information was arranged such that the identity of the individual student was stripped from the file and only information pertinent to this study remained.

Statistical Procedures

In this study it was desirable to examine the data in a descriptive manner. A frequency distribution for each of the following parameters was performed using the SPSS (Statistical Package for the Social Sciences). For each of the first and second year science courses at Pima College a cross-tabulation of each course by sex, ethnic, racial group and grade was made. The frequency distributions were then extracted from the cross-tabulations and analyzed.

Assumptions

The assumptions listed below were considered important for the analysis of this study.

1. The population involves a normal distribution of intelligence.

2. The sex of the student did not effect the grade received.

3. The race or ethnicity of the student did not effect the grade received.

4. The professor taught the class in an unbiased manner regarding sex, age or ethnicity.

Limitations

The major limitation of this study is that it applies to a particular group, that is, those students who passed the first and second year science courses at Pima College.

Those students who did not pass the courses with a C grade or better but did register for the courses are not considered in this study. The reasons that they did not pass the courses or dropped out of the courses may have a bearing on this study. However, inspite of this limitation the study was conducted and data analyzed based on students who completed and passed the courses.

Definition of Terms

First and second year science courses:

ASTRONOMY (AST) 101, 102

BIOLOGY (BIO) 101, 102, 184, 190, 195, 201

CHEMISTRY (CHM) 080, 121, 151, 152,

EARTH SCIENCE (ESC) 101, 102

PHYSICS (PHY) 121, 122, 210, 216, 221

First year courses: any course numbered at or below 122.

Second year courses: any course numbered above 122.

RESULTS

A sample of 5940 students who passed the first and second year science courses at Pima College was examined. The results of the frequency distribution, by sex, is presented in Table 3.

Table 3

Frequency Distribution by Sex and First and Second Year Science Courses at Pima College

Course	Male		Female	
	Freq.	%	Freq.	%
AST 101	422	50.4	416	49.6
AST 102	406	53.9	347	46.1
BIO 101	295	51.9	273	48.1
BIO 102	170	51.5	160	48.5
BIO 184	13	44.8	16	55.2
BIO 190	31	49.2	32	50.8
BIO 195	4	50.0	4	50.0
BIO 201	258	49.5	263	50.5
CHM 080	267	49.4	273	50.6
CHM 121	215	55.0	176	45.0
CHM 151	349	58.1	252	41.9
CHM 152	154	53.8	132	46.2
ESC 101	66	55.9	52	44.1
ESC 102	40	54.8	33	45.2
PHY 121	254	54.3	214	45.7
PHY 122	72	52.2	66	47.8
PHY 210	58	47.5	64	52.5
PHY 216	31	48.4	33	51.6
PHY 221	27	42.9	36	57.1

The information in Table 3 revealed that the percentage of students, by gender, is approximately 50 percent male and 50 percent female for first and second year science courses at Pima College. The totals for the columns in Table 3 are found in Table 1. In Table 4 below, the frequency distribution of students into the various first and second year science classes is presented.

Table 4

First and Second Year Class Distribution

Course	Absolute Freq.	Adjusted Freq. (%)
AST 101	838	14.0
AST 102	753	12.6
BIO 101	568	9.5
BIO 102	330	5.5
BIO 184	29	.5
BIO 190	63	1.1
BIO 195	8	.1
BIO 201	521	8.7
CHM 080	540	9.0
CHM 121	391	6.5
CHM 151	601	10.1
CHM 152	286	4.8
ESC 101	118	2.0
ESC 102	73	1.2
PHY 121	468	7.8
PHY 122	72	2.3
PHY 210	58	2.0
PHY 216	64	1.1
PHY 221	27	1.1

The indication, from the data in Table 4, is that most students registered for and passed AST 101. This is the introductory astronomy course. The classes with the lowest enrollments tended to be the physics (PHY) courses. However, percentage wise, the approximately 50 percent male/female distribution was still apparent.

Table 5

Total Population of All Registered Students in First and Second Year Science Courses at Pima College

Course	Absolute Freq.	Adjusted Freq. (%)
AST 101	1677	12.1
AST 102	1527	11.0
BIO 101	1409	10.2
BIO 102	685	4.9
BIO 184	113	.8
BIO 190	232	1.7
BIO 195	48	.3
BIO 201	1488	10.7
CHM 080	1230	8.9
CHM 121	541	3.9
CHM 151	1512	10.9
CHM 152	684	4.9
ESC 101	182	1.3
ESC 102	180	1.3
PHY 121	1220	8.8
PHY 122	310	2.2
PHY 210	432	3.1
PHY 216	209	1.5
PHY 221	177	1.3
Total	13856	100.0

A frequency distribution by grades is presented in Table 6.

Table 6

Frequency Distribution by Grades of The First and Second Year Science Courses at Pima College

Grade	Absolute Freq.	Adjusted Freq. (%)
A	2396	17.3
B	2128	15.4
C	1450	10.5
D	351	2.5
F	353	2.5
Incomplete	58	.4
Pass	24	.2
W/Draw Stu.	1971	14.2
W/Draw Prof.	726	5.6
No credit	4383	31.6
Audit	16	.1
Total	13856	100.0

Until recently, Pima College had a rather strange withdrawal policy. A student could withdraw from class up to the last day of classes. This was corrected and the new policy has been in effect since the Fall 1989 semester. Students can not withdraw passed the tenth week of class.

The no credit grade, which is at 31.6 percent in Table 6 indicates that most students did not finish any of the first or second year science courses. The audit grade is taken for no credit. The withdrawn student grade or the withdrawn professor grade was equivalent under the old policy.

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

Since the first two years at Pima College are the first two years for science majors transferring to a university, students registering for and passing the first and second year science courses at Pima College, according to the data, were found to be typical as indicated by the study done by Baker in which he states that "approximately half of all undergraduate majors in science are female." Furthermore, this study showed that at Pima College, women did slightly better in the second year physics courses than did men. This trend was noticed in the upper level biology courses as well. It was found that while the numbers of students who actually completed the courses with a C grade or better verses those that registered for the science courses was only 43.1 percent. This population, of 5974 students, was composed of approximately 50 percent female as was the total population of 13856 students who had registered for the first and second year science courses but had not completed or passed the courses with a C grade or better. Not only are women well represented in the first year and second year sciences courses at Pima College, but they actually did slightly better than the male students in the upper level classes. It would seem that Pima College is a typical institution as far as its two year science programs regarding gender and enrollments. The implication

is clear that Pima College has, either by accident or design, set up its programs and counseling regarding science education and gender in an unbiased manner. Also, the teaching of these science courses was probably free from gender bias as well, if not why would the male/female ratio remain fairly constant? It would be interesting to follow the students as they continue into the university environment and determine if they continue with such unbiased situations as they have experienced at Pima College.

However, this study uncovered a rather frightening fact. It seems that of all the students who registered for the first and second year science courses at Pima College 56.9 percent dropped out of or did not pass the courses. The 31.6 percent, no credit drop out, students found in Table 6 may have indicated that many students apparently could register for courses that they could not do well in. It was discovered, in a previous study, that the assessment tests used were not able to predict student success in the PHY 121 course at Pima College. In that previous study, "it was recommended that the assessment test components be examined as to their ability to accurately assess students", (Iadevaia, 1989:111). It should be stated that since the Fall 1989 Semester, students could no longer withdraw from a course after the tenth week of class. The data used for this study

contained a student population who could have withdrawn from a course on the last day of class after the final examination was given. It is too early to assess the effects of this new policy regarding withdrawals. Therefore, while it was apparent a great number of students, for whatever reason, concluded their course work early the male/female ratio was still approximately fifty percent thus verifying Baker's observation.

It was recommended to the college that a continuation of the procedure, if any, be used in maintaining female enrollments in the first and second year science courses. If there is no procedure, then a formal procedure should be established to see to it that female enrollment is maintained. It was also recommended that longitudinal studies be carried out on those women who transfer to the university and continue their science programs past the bachelors degree. A program should be established where female students can interact with female scientists, either through a cooperative education program or seminars. Finally, it was recommended that the college investigate the reasons that such a high number of students registered for the first and second year science courses then dropped out.

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APPENDIX A

MEMORANDUM FROM THE DEAN OF THE SCIENCE DIVISION

Inter-OfficeMemorandum
PimaCommunityCollege

TO: David Iadevaia

FROM: Ken McCollester

DATE: 3 April 1989

SUBJECT: WOMEN IN PHYSICAL SCIENCE

This memo serves to confirm our earlier conversation and supports your research efforts in the area of women in physical science.

We both know that the physical science field is dominated by males. I frankly am unaware of the extent of this dominance, especially at the community college level. I highly applaud and support your efforts to provide data in this critical area. It is important that all of us make special effort to encourage women and minorities to enter this field.

I look forward to seeing the results of your study and place whatever resources you may need at your disposal.

Thank you for sharing your ideas and concerns.

APPENDIX B

LETTER FROM THE MATH AND SCIENCE DIVISION

COUNSELOR

Pima Community College Twenty Two Hundred Two West Anklam Road, Tucson, Arizona 85709-0001 (602) 884-6666

April 4, 1989

Dear David,

I am excited about the study you are about to undertake. I think it will be of enormous value to the Pima Community College Math & Sciences Division at the West Campus and particularly to our Math & Sciences Advising & Counseling Center. Your interest and delight in teaching and learning has always been refreshing. I foresee your research study as a necessary tool in increasing our understanding of student enrollment and learning in the sciences. I wish you the best in conducting your study and please let me know if my office can be of any assistance to you in your work.

Sincerely,

Cynthia Arem PhD

Cynthia Arem Ph.D.

Math & Sciences Division
Counselor